

NAVAL POSTGRADUATE SCHOOL MONTEREY, CALIFORNIA



THESIS

THE EFFECTIVENESS OF
VIDEOTELETRAINING
AS A LEARNING MEDIUM

by

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December 1996

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**THE EFFECTIVENESS OF VIDEOTELETRAINING
AS A LEARNING MEDIUM**

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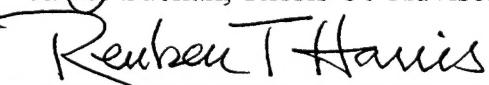


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ABSTRACT

The Department of Defense (DoD) is implementing distance learning to augment and replace current military education and training programs.

Distance Learning (DL) methods using technology such as video teleconferencing (VTC) and the Internet are expected to provide immense cost and time savings when properly implemented and supported. Implementing a successful DL program requires a clear understanding of the unique interactions and characteristics of the technology, the environment, the roles of the instructor and students, and the appropriate instructional methods. Gaining a clear understanding of a successful program necessitates a framework to assess the effectiveness of distance learning programs. This research proposes a learning effectiveness model for distance learning. Model constructs include the learning effectiveness of instructor/students, interactivity, organizational characteristics, goals and technology. These constructs form the basis for the distance learning model. Three Naval Postgraduate School (NPS) DL courses are analyzed using the model to illustrate its flexibility and predictive nature. This analysis showed that the model's constructs interact to produce a system that supports a complex relationship. Interactions between technology, the environment, instructional techniques, student effectiveness combine to produce different outcomes. Feedback is an important system mechanism that allows verification that the course learning objectives are being achieved.

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I. AN INTRODUCTION TO DISTANCE LEARNING

Distance learning education, as defined for use in this thesis, is characterized by the use of an electronic medium to conduct learning with time and geographical separation between the instructor and student. Courses taught via distance learning may involve several sites that are physically separated, with real time interaction conducted via telecommunications among the participants. Sherry (1994) cites other definitions by various researchers. She states characteristics of distance learning as those:

that describe distance learning's hallmarks as the separation of teacher and learner in space and/or time (Perraton, 1988), the volitional control of learning by the student rather than the distant instructor (Jonassen, 1992), and noncontiguous communication between student and teacher, mediated by print or some form of technology (Keegan, 1986; Garrison and Shale, 1987). (Sherry, 1994)

This chapter begins with a discussion of the evolution of telecommunications to its present day conception of distance learning. As the use of distance learning expands and increases in popularity, differences in methodology and educational models are emerging between the traditional structure of the classroom setting and distance learning setting. These differences are exposing the weak points of the traditional models when applied to distance learning and raising awareness for the need of a dynamic educational model suitable for distance learning programs. Addressing these differences to distance training and education raises several research questions that need to be examined in order to create effective distance learning programs. The chapter concludes with a discussion of these research questions that need to be addressed by distance educators and trainers to accommodate the inclusion of video telecommunications in the classroom and training facility.

A. EVOLUTION OF TELECOMMUNICATION, VIDEO, AND EDUCATION

1. Educational Evolution

The way courses of instruction have been taught has largely remained unchanged until recently. Communications technology is rapidly transforming the paradigm of the

traditional educational classroom and the context in which students and instructors interact.

The textbook or printed material was the basic unit used to supply information. Students were the recipients of information rather than active participants in learning as teachers used lecture and chalkboard to convey information. Early communication advances such as television and radio experienced drawbacks as educational instruments largely because they were broadcast only and not a two-way communication channel. But during the last half of the twentieth century, diverse innovations in communication and computation occurred, displacing textbooks from their educational position and creating our current, electronic means of access to instructional assets.

As a result of the displacement of books as the prime medium of cultural exchange, educators have had to radically rethink the educational system and its instructional techniques. The traditional system functioned to optimize techniques and programs within its own classroom boundaries. Almost all of its methods for the measurement of system results assumed that existing divisions of subject matter were the appropriate domains for testing. Educators slowly turned from applying computers to the educational strategies that had been developed in the early era of print to search for educational strategies that seemed sensible in an era of digital information. As the search for strategies continues, assumptions about the physical location of education and the traditional classroom are being scrapped in favor of flexible scheduling and constructive active participation by students.

2. Current Uses of Telecommunications for Education

Telecommunications has evolved to an infrastructure consisting of telephones, broadcast systems, cable, and electronic networks. Educational applications continue to evolve as telecommunication media increase in complexity and grow to widespread use. These educational applications include:

- Instructional video using cable television or cassette videotapes for instruction is widely used in the school system and workplace. Advances in technology are

resulting in the expansion of this system using fiber optics, satellites, and computers.

- Information collection is becoming easier with the growing use of electronic libraries that can be accessed from work or home. The personal computer equipped with an Internet browser application and modem allows convenient access to large numbers of educational sites. Commercial Internet Service Providers like America On Line and CompuServe incorporate access to periodicals, newspapers, email, and Internet service into convenient affordable packages that have become common household items.
- Communication via teleconferencing and electronic mail allows conversation with mentors, teachers, students, technicians, and subject matter experts of every sort.
- Transfer of instructional simulations and software can be performed over the Internet and delivered to schools, workplaces, and homes.
- Courses taught via two-way audio and video are commonplace, with a large number of universities, colleges, and schools offering programs using this method.

This educational method is called distance learning. This area is of particular interest to the Department of Defense which has invested heavily in the development and implementation of networked distributed interactive simulation.

B. DISTANCE LEARNING BENEFITS

1. Benefits of Distance Learning

The learning relationship is changed from the common centralized school model to a more decentralized and flexible system. The school is brought to the students, rather than the students coming to the school. Distance learning has recognized benefits over the traditional classroom. The most prevalent three benefits are resource sharing, real time collaboration, and data access.

a. Resource Sharing

Access to resources is greatly enhanced in the distance learning environment. Resource sharing improves educational quality by providing direct links to a wide variety of courses and network appliances such as remotely controlled instruments that perform specific operations based on information provided from multiple servers and clients. Universities and research institutions can share courses and data to augment local research efforts or collaborate on complex projects. Resource sharing is also an effective method for trimming costs.

b. Real Time Collaboration

As bandwidth requirements are being met, although slowly, scholars are able to collaborate on a variety of levels and varying degrees. Real time interaction allows dispersed research teams to exchange data and successfully complete complex projects. Real time collaboration allows compression of project lead times and reduction in administrative overhead. Universities and other educational institutions can take advantage of team teaching, in which several faculty from various locations teach a single course that is distributed to several locations using interactive multicast protocols.

c. Access to Data

Research requires access to large and relevant sources of data. Data sets are usually stored in chunks and are not replicated from data site to site. Distance education allows continuous access to disparate chunks of knowledge without the need for the researcher to physically visit the data facility. Data from different sites can also be conveniently compared, manipulated and replicated to local storage media.

C. DIFFERENCES BETWEEN TRADITIONAL EDUCATION AND DISTANCE LEARNING

1. Educational Roles

The roles within the distance learning environment are very different than that of the traditional classroom. Students find that they have to participate as an active learner in the course in order to guide the learning outcomes. Students affect the manner in which

they deal with the material to be learned. They must have a sense of ownership of the learning goals and must be willing and able to receive instructional messages. Students must quickly become aware of and comfortable with new patterns of communication, learn to manage their time, and take responsibility for learning. Sylvia Charp (1994) " notes that with greater autonomy, student characteristics such as active listening and the ability to work independently in the absence of a live instructor become crucial for success" (Sherry, 1994).

Instructor's roles evolve also in the distance learning course. Instructors must possess the ability to work well as a team with the site facilitator and students. They must devote more time to preparation as material format becomes important in the consideration of text, graphics, audio and video capabilities which impact the distance learning presentation. Sherry (1994) mentions other research findings that corroborate the skills needed by instructors. She states that Schlosser and Anderson (1993) have identified the following skills which teachers must learn as they assume the role of distance educators:

- understanding the nature and philosophy of distance education
- identifying learner characteristics at distant sites
- designing and developing interactive courseware to suit each new technology
- adapting teaching strategies to deliver instruction at a distance
- organizing instructional resources in a format suitable for independent study
- training and practice in the use of telecommunications systems
- becoming involved in organization, collaborative planning, and decision-making
- evaluating student achievement, attitudes, and perceptions at distant sites
- and dealing with copyright issues. (Sherry, 1994)

The role of facilitator is created with the distance learning course. The site facilitator is an extension of the instructor. The responsibilities of the site facilitator include motivation and encouragement of students, maintenance of discipline, equipment operation, collecting and handing out course materials/tests, and other miscellaneous tasks to assist the instructor.

2. Interactivity

A major difference with the implementation of distance learning is how to create and maintain a sufficient level of interactivity that is often present in the traditional classroom. Courses taught with telecommunications present problems to both instructors and students comfortable with traditional interaction. Interactivity is limited by the physical limitations of the technology, such as the camera angle and number of cameras, delays which interrupt the pace of the course, by bandwidth constraints, and instructor/student inability to interact in a remote sense without relying on face-to-face traditional cues.

3. Technology

Technology is related to increases in student performance when interactivity and other important features of instructional design are applied to its use. These other features are teacher preparation, follow-up staff development, and technical assistance. The Office of Technology Assessment (OTA) conducted a comprehensive nation-wide assessment at the request of the Senate and House Committees on Education and Labor. The study showed that with adequate teacher preparation technology greatly facilitates:

- Teaching of abstract concepts and problem solving, as well as basic skills
- Independent work, teamwork and collaborative inquiry
- Adaptation of instruction to accommodate student learning styles and special needs
- Higher expectations of students and presentation of more complex materials
- Less teacher lecture, with more student-centered classrooms
- Opportunities for new learning experiences (OTA, 1995).

D. THE PROMISE OF FUTURE EDUCATION

The Department of Defense (DOD) and other associated research/training activities are using video teleconferencing, the Internet, and other electronic-based forms of communication to change the role of education and training. DOD educational and training efforts could benefit by the expanded use of distance learning to decrease travel and related training expenses, increase the flexibility of current training programs, offer

training on a just-in-time basis, increase data accuracy and access to field experts, and optimize the use of training time.

1. Education on a Just-in-Time Basis

Educators and trainers look at the classroom of the future and see an environment where students have the ability to take charge of their learning using technology within the environment to access and manipulate instructional media, collaborate with peers and subject matter experts, and provide guidance which allows them to modify their constructs. Access is available on a continuous basis from many remote locations, allowing students to receive training and education as required. This educational system requires development of new models and instructional strategies to establish measures of effectiveness for and qualify the benefits of a distance learning educational system.

2. Department of Defense Benefits

a. Highly Skilled Fighting Force

During the last five years, the military has had significant cuts in military and civilian personnel levels and in levels of funding. A budget conscious environment demands judicious use of scarce resources to attain and maintain a technological and highly trained fighting force. The reduction in force size also demands that the military operate effectively with other forces to achieve a joint synergistic relationship. The advent of an information intensive and complex battlefield demands a skilled and well educated force to carry out the assigned missions and objectives successfully. The use of distance learning in the classroom and training environment is proving to be a viable alternative method of providing the necessary training to attain and maintain warfare skills while conserving the training dollar. Simulations and computer based training are helping widely dispersed forces collaborate on combined training exercises to achieve interoperability and joint force proficiency.

b. Budget Conservation

The lack of travel and training funds have provided a catalyst for the innovation of the traditional classroom education. Videoteletraining has been implemented as a cost effective means to access needed training and education. Schools view

videoteletraining as cost effective because fewer instructors can reach a greater number of students than was previously possible in the traditional classroom. The scheduling of the courses can also be more flexible to accommodate students at a distance. Travel and other associated costs are diminished with training occurring locally. Educational resources are available on an as-needed basis with convenient access to subject matter experts, research data, and scientists. Data replication and storage costs can be cut with a centralized facility serving many sites.

3. Future Educational Strategy

Well-designed technology-based training can provide greater mastery of material in less time and with higher employee/student satisfaction than the average classroom lecture. But the teaching strategies based on the old educational system are simply inadequate for a computer and communications based distance learning environment. A needs assessment for distance education conducted by Sherry and Morse (1994) identified several important issues such as “redefining the roles of key participants, technology selection and adoption, design issues, strategies to increase interactivity and active learning, learner characteristics, learner support, operational issues, policy and management issues, equity and accessibility, and cost/benefit tradeoffs” (Sherry, 1994).

Sherry (1994) has included remarks on other studies that have asserted the need for interactivity. She notes that:

successful distance education systems involve interactivity between teacher and students, between students and the learning environment, and among students themselves, as well as active learning in the classroom. McNabb (1994) noted that, though students felt that the accessibility of distance learning courses far outweighs the lack of dialogue, there is still a considerable lack of dialogue in telecourses when compared to face-to-face classes. (Sherry, 1994)

New educational strategies are required that incorporate technology within this new educational setting in a complementary way while providing maximum benefit for the training dollar. The new educational strategy would utilize a proper mix of technology and interactivity to allow students to take active control of their education and training. New measures of effectiveness designed to detect proficiency in the appropriate subject

matter/training area need to be established to provide a quantitative conclusion about the overall training effectiveness of the distance learning program.

E. OBJECTIVES AND RESEARCH QUESTIONS

1. Objective

The objective of this research is to examine current distance learning studies and research programs to determine effective criteria that are relevant to distance learning and education. Acknowledging the differences between a traditional educational environment and a distance learning environment develops the requirement to establish an educational model that is unique to distance learning and based upon these relevant criteria. This study will broaden the Department of the Navy's understanding of the unique environment of distance learning and its associated educational demands. These factors need to be examined in order to establish effective distance learning programs that optimize the use of the training dollar.

2. Research Questions

The following research questions will be addressed:

- *Do relevant criteria exist for the estimate and evaluation of a distance learning program?*
- *How do humans learn and what are the prevalent learning styles?*
- *How does videoteletraining change these styles?*
- *How does the role of the instructor and student change with the use of a videoteletraining program?*
- *If relevant criteria exist for distance learning, can these criteria provide a research design for measuring the effectiveness of a distance learning program?*

3. Scope and Limitations

a. Scope

This thesis examines current distance learning research and looks for common, recurring elements of distance learning programs that would suggest crucial constructs of distance education. These constructs, if found, will form the basis for the

establishment of a distance education model that might be used to determine the effectiveness of a distance learning program. The thesis will examine the model in terms of these constructs and their relationships to one another. The developed model will then be applied to three Naval Postgraduate School courses to demonstrate its applicability.

b. Limitations

The data gathered for this research was acquired by extensive examination of current distance learning programs and research efforts available from current literature. The thesis lacks a survey or similar instrument in using the established data to validate a distance learning model. A future extension of this research should take the results of this thesis and attempt a feasible distance learning course application as a research instrument to validate the findings of this study.

4. Organization of The Thesis

Chapter II looks at existing distance learning literature to provide a basis for the constructs of a distance learning effectiveness model and point out the fact that no educational model for distance learning exists.

Chapter III develops the distance learning constructs and their interrelationships into a distance learning model.

Chapter IV applies the developed model and its elements to two courses taught at the Naval Postgraduate school to illustrate the validity of the model.

Chapter V develops a conclusion and makes recommendations based upon the results of the model development and course application covered in Chapters III and IV.

II. DISTANCE LEARNING LITERATURE REVIEW

This chapter provides insight into current literature that considers distance learning and its growth among educational and training institutions. Different styles of learning and their adaptation to distance learning and the video teletraining environment are discussed. The chapter then examines literature concerning technology in the classroom, the changing role of the instructors and students, the concept of effectiveness, and the critical role of interactivity. The chapter concludes by recognizing the deficiency of current research concerning distance learning educational models.

A. LEARNING STYLES

Relevant research in the area of distance learning and education recognizes the incompatibilities of the traditional learning strategies in the classroom and the distance learning environment. Kearsley and Moore (1996) state that "the successful use of communication technologies, however, requires special design techniques and more careful planning and production than is usual in classroom teaching" (Kearsley and Moore, 1996). To simply mirror the environment of the traditional classroom is not enough in the video tele-education (VTE) environment.

Instruction via telecommunication requires changes in the learning styles to create an effective learning environment. Students and instructors find that the teaching- learning interaction is diminished and different than that of the traditional classroom. New strategies and models for education need to be devised that deal with the distance learning environment and generate effective learning in these programs.

There are a wide variety of suggestions for possible successful learning strategies for the distance learning environment, but none have been formulated into a dynamic model for study. Schlosser and Anderson (1994) assert that an appropriate model for the distance learning program is to recreate the experience of traditional, face-to-face instruction, via intact classrooms and live, two-way audio-visual interaction. The basis for this model is Keegan's theory of distance education, "in which the distance learning system

must artificially recreate the teaching-learning interaction and re-integrate it back into the instructional process" (Sherry, 1994).

Sherry cites another work by Willis (1993) that describes other strategies which are effective in distance learning:

namely, developing appropriate methods of feedback and reinforcement, optimizing content and pace, adapting to different student learning styles, using case studies and examples which are relevant to the target audience, being concise, supplementing courseware with print information, and personalizing instruction (Sherry, 1994).

A promising approach is based on constructivist principles, in which a learner actively constructs an internal representation of knowledge by interacting with the material to be learned. Sherry (1994) defends this viewpoint as the basis for both situated cognition and problem-based learning. She states "both social and physical interaction enter into both the definition of a problem and the construction of its solution" (Sherry, 1994).

Further, Prawat and Floden (1994) state "that to implement constructivism in a lesson, one must shift one's focus away from the traditional transmission model to one which is much more complex, interactive, and evolving" (Sherry, 1994).

B. TECHNOLOGY IN THE CLASSROOM

Distance learning by virtue of its definition involves some form of telecommunication in the conduct of the course. The rapid advancement of communications technology is forcing educators to shift their mental models associated with the traditional classroom.

Research efforts agree that technology is beneficial to the classroom. Well-designed technology-based training can provide greater mastery of material in less time and yields higher student satisfaction. A study by Robson (1996) demonstrated that the teleconferencing environment is supportive and can cater to a variety of learning styles. The study observed learning outcomes from a mathematics course implemented using video telecommunication to support the hypothesis that distance learning offered a comparable if not superior learning environment. The results indicate that the attitudes

toward the subject and towards the learning environment provided were positive and that the learning outcomes were similar to those students studying via the traditional learning style in the classroom.

The Office of Technology Assessment (OTA) published findings that concluded “helping teachers effectively incorporate technology into the teaching and learning process may not only help students become competent technology users, but may also help them become more accomplished learners overall, with skills necessary for the information age” (OTA, 1995).

In a distance learning environment, technology assumes some of the roles once held by teachers. Technology assumes the role of a delivery system letting instructors manipulate visual and audio presentation creatively, providing motivation to students as they experience new educational possibilities, and serving as the medium with which students and instructors experience interaction. In the literature there is a distinct lack of knowledge about alternate models of assigning teachers their time and tasks when there is a change in roles brought about by technology.

Another question raised by the research community is: How to make effective investments and use of technology in the distance learning environment. The OTA (1995) study suggests that “funders might be willing to make greater investments in educational technology and related professional development if there were better research suggesting the conditions under which such investments would be most effective...” (OTA, 1995). Robson (1996) approaches the issue of effectiveness and technology by considering the student attitudes towards the teaching and learning situation, and by comparing the outcomes with the goals of the program. The idea is presented that a measure of effectiveness for technology is not as much about its usefulness as its wise use. Further research is needed to examine the wise use of various technology tools and effective applications in a distance learning environment.

C. ROLE CHANGES

Distance learning invokes some changes in the roles of course participants.

Courses can become miniature productions that require familiarity with the technology, good speech and listening skills, and changes in material/media format. Most researchers and studies readily acknowledge that the role of the student and instructor changes in the distance learning environment.

1. Instructor

The role of the instructor is modified to that of an “adapter” who must modify instructional preparation and techniques to the characteristics of the technology. This role modification is recognized by Sherry (1994) who states, “effective distance learning requires extensive preparation, as well as adapting traditional teaching strategies to a new learning environment which often lacks visual cues” (Sherry, 1994). A range of skills are demanded of the distance learning instructor to successfully adapt to the VTE environment. The wide variety of required skills often means extensive course preparation time to ready the material for delivery in an acceptable manner. Some characteristic skills are described by Sherry (1994) as:

- “training in instructional design
- strategies for delivering instruction on-camera
- methods of diversifying types of presentation
- selecting various mixes of student-teacher activities and interactions
- choosing situations and examples which are relevant to their students
- and assessing the level of learning by distant students”(Sherry, 1994).

Other needed skills involve hands-on experience dealing with the development and delivery of course material using the available technology in front of a live audience. A study conducted by Willis (1993) describes other effective strategies involved in distance learning such as “developing appropriate methods of feedback and reinforcement, optimizing content and pace, adapting to different student learning styles, using case studies and examples which are relevant to the target audience, being concise, supplementing courseware with print information, and personalizing instruction” (Sherry, 1994). Other

researchers, such as Schlosser and Anderson (1993) also identified other skills for the distance educator that have been discussed in Chapter I.

Reibel and Fellow (1994) go on to suggest that as the work that constitutes a teachers role in the classroom changes, so to should their professional development processes change to meet the challenge of required skills.

2. Student

The student role in a distance learning course is also different. The learning conditions are changed with students utilizing active inquiry and communication to participate in the course. Students should operate at a collaborative level rather than a competitive one. Students act with more autonomy and initiative in the environment as they engage in inquiry. Learners discover and construct meaning as they interact with their environments to modify and increase the complexity of their ideas in light of new data. They actively construct their own knowledge by mediating input from the instructor and other learners. This method of learning is called constructivism and suggests itself as an appropriate theoretical framework for the distance learning environment because learning is active mental work, utilizing the student's cognitive abilities to increase and modify existing notions through inquiry.

Crotty (1995) refers to Lebows five principles which support the use of opportunities for learners to engage in distance learning experiences as a means of challenging students to construct their own meaning with the help of others. These principles give insight as to the characteristics of the student role. These five principles are:

- "maintain a buffer between the learner and the potentially damaging effects of instructional practices.
- provide a context for learning that supports both autonomy and relatedness.
- embed the reasons for learning into the learning activity itself.
- support self-regulated learning by promoting skills and attitudes enabling the learner to assume increasing responsibility for the developmental restructuring process.

- strengthen the learner's tendency to engage in intentional learning processes, especially by encouraging the strategic exploration of errors". (Crotty, 1995)

D. EFFECTIVENESS

Discussions of effectiveness and its relationship to distance learning are numerous and varied within the literature. The context of effectiveness is applied to the instructor, student, technology, environment, and the methodology used in the distance learning program. The literature agrees that distance learning needs to have measures of effectiveness to establish a reference point for measuring the value of the distance learning classroom. But relative specifics about the effective use of distance learning education and its associated elements is sparse and varied in defining a rigorous definition for the term effectiveness. This problem is recognized by Dean, Biner, and Coenen (1995) who comment on the value of research that compares tele-education to traditional education, but indicate that the research does not move substantially beyond this issue of performance. Investors, educators, and legislative bodies will continue to show reluctance in investing in such programs until such measures are defined to validate the value and relative worth of distance learning.

1. Instructor Effectiveness

Issues surrounding the capability, knowledge, motivation, and performance of distance learning instructors are labeled instructor effectiveness. Effective presentations in the distance learning classroom depend on an instructors familiarity with the instructional design and delivery process. Proper strategy selection for delivering on-camera, diversified presentations and selection of situations, examples that fully utilize the interactive capacity of the course are characteristic of an effective instructor. Willis (1993) describes other strategies that effective instructors use, such as "developing appropriate methods of feedback and reinforcement, optimizing content and pace, adapting to different student learning styles, using case studies and examples which are relevant to the target audience, being concise, supplementing courseware with print information, and personalizing instruction" (Sherry, 1994).

As instructors assume the tasks and roles involved in the distance learning course and gain proficiency, they become more effective instructors.

2. Student Effectiveness

Most literature characterizes an effective student in the distance learning course as possessing a positive attitude toward the course and the motivation to act independently. To be effective, “students must quickly become aware of and comfortable with new patterns of communication, learn to manage their time, and take responsibility for their own learning” (Sherry, 1994).

Charp (1994) “notes that with greater autonomy, student characteristics such as active listening and the ability to work independently in the absence of a live instructor become crucial for success”(Sherry, 1994). A student who takes a distance learning course needs a motivated, positive attitude in order to succeed. Motivation and attitude help support the student in a course where a large part of learning responsibility lies with the student to achieve the learning outcomes.

3. Technology Effectiveness

The proper role of technology in distance learning is its placement to support the learning environment. An environment properly supported by technology is an asset to the program and helps shape student and instructor attitudes toward distance learning. Effective use of technology requires the teacher to possess a firm understanding of the technological potentials, opportunities to apply them, training and just in time support, and time to experiment.

Technology can bring demonstrations of the best VTE teaching live from the classroom into the colleges of education, or provide video case studies of teaching styles and approaches. It can forge stronger connections among student teachers, mentor teachers in the field, and universities' various departments, particularly education.

The support of advanced knowledge acquisition can be done by providing environments and thinking tools that engage constructivistic conceptions of learning. Open learning environments are technology supported systems that are examples of open systems. In open systems, the goals of the system, questions such as its uses, activities and

options, are determined both by sources internal and external to the system. Open learning system are those that are need driven, learner-initiated interaction, and conceptually and intellectually engaging.

A traditional computer-based learning environment usually has a prescriptive program that allows the input of information; however, often the response to the input is prescribed and predetermined. An Office of Technology Assessment study (1995) recognizes that "helping teachers effectively incorporate technology into the teaching and learning process may not only help students become competent technology users, but may also help them become more accomplished learners overall, with skills necessary for the information age"(OTA, 1995). While a lot is known about technology as a whole, little is known how technologies work for teachers, and how technology changes teaching, and, if so, for which teachers and under what conditions. An alternative model is needed for distance learning to redesign the roles and duties of teachers and students in the classroom.

4. Feedback

An educational dynamic model that is composed of technology, the environment, and revised roles requires a method to validate and measure the level of effectiveness in the program. The traditional measurements were based on well defined subject matter boundaries and associated tests to determine learner retention and cognitive abilities. The importance of feedback in the distance learning classroom is supported by several literature studies. Willis (1993) notes that among strategies which are effective in distance learning, one is "developing appropriate methods of feedback and reinforcement," (Sherry, 1993). Selden (1996) reports that the Instructional Development and Evaluation Assessment (IDEA) system used by Kansas State University utilizes student feedback to indicate how well the course objectives have been achieved. Instructors using the IDEA method are convinced of its effectiveness in determining intended outcomes versus actual outcomes. The constructivist methodology as described by McKenzie (1996) portrays teachers as "allowing student responses to drive lessons, shift instructional strategies, and alter content" (McKenzie, 1996). Using constructivism successfully in the distance

learning classroom requires adequate feedback to allow redirection of learning and validate the achievement of the course learning objectives.

E. THE ROLE OF INTERACTIVITY

In conducting the review of distance learning research, the process of interactivity and its importance in the educational setting of the distance learning classroom surfaced time and again. Studies by Hough (1984), Kozma (1986), and Hackman and Walker (1992) concluded “that the more effective tele-educational systems are those with the greatest interactivity, immediacy, and user control, used to convey highly instrumental information to motivated students” (Hackman and Walker, 1994). Sherry (1994) maintains that “successful distance education systems involve interactivity between teacher and students, between students and the learning environment, and among students themselves, as well as active learning in the classroom” (Sherry, 1994).

Interactivity is a multi-path process that can be generated and strengthened in a distance learning environment. Interactivity takes many forms and represents the connectivity the students feel with the distance learning instructor and peers.

The concept of interactivity in a distance learning environment is explored by several researchers with regard as how to start it, how to strengthen it and how to keep the process sustained. Garrison (1990) argued “that the quality and integrity of the educational process depends upon sustained, two-way communication” (Sherry, 1994).

An effective method for the generation and sustainment of interactivity appears to be priming. Priming is analogous to “breaking the ice” in the distance learning environment. Mercer and Harrington (1995) liken priming to breaking through the electronic barrier in order to create an encouraging atmosphere to positively influence the attitudes of the students. They include four techniques to influence the environment which are:

- occasional reference to the distance learning experience
- calling students by name
- keeping participants informed of what is happening

- inclusion of informal interaction.

Hackman and Walker (1994) found similar results and state "when the system of conveyance allows interactivity and control, and when instructors are immediate and present, students learn more and are more satisfied with the experience regardless of the modality" (Hackman and Walker, 1994).

The process of interactivity and the level it is sustained at, suggests a key element of an educational strategy applicable to a distance learning program and environment. Interactivity strengthens and supports the constructivist methodology by serving as a conduit for connectivity.

F. NEW EDUCATIONAL MODEL

1. Educational and Training Need

Distance education has arrived. Many organizations are using video teleconferencing, the Internet, and other electronic-based forms of communication to change the role of education and training. The Department of Defense educational and training efforts could benefit by the expanded use of distance learning to decrease travel and related training expenses, increase the flexibility of current training programs, offer training on a just-in-time basis, increase data accuracy and access to field experts, and optimize the use of training time.

2. Educational Model Requirement

A key factor lacking in current research is the absence of systematic measures of effectiveness and an educational model based on distance learning. A systems model needs to be developed which takes into account all major elements of telecommunications education. Such a model should ideally broaden the focus of the current research by identifying important variables to be studied, stimulate more scientifically rigorous research to assess the degree to which these variables interact in affecting the learning process, and provide both guidance and direction to researchers in the field by indicating gaps in our current knowledge.

Distance education programs adapted to the traditional educational models and teaching methodologies have not achieved the desired outcomes and have exposed the weaknesses associated with the traditional methods. A new educational model for distance learning is required for the successful evolution of education to a distance learning environment. This new model requires measures of effectiveness to determine the achievement of intended outcomes versus actual outcomes of the learning objectives. The traditional educational model lacks the support, flexibility, and dynamics to adapt to the distance learning environment.

The elements of technology, environment, student effectiveness, instructor effectiveness, feedback and interactivity are discussed in great detail throughout the literature as crucial elements and characteristics of successful distance learning. These elements should be considered as components for the foundation of an educational model that deals with the unique characteristics of distance learning.

Chapter III proposes such an education model that is based upon these elements and unique characteristics identified in the distance learning literature. This chapter discusses the interactions and processes of the elements and the model relationship to the methodology of constructivism.

III. AN EXPERIMENTAL MODEL

A. ELEMENTS AFFECTING LEARNING EFFECTIVENESS

This chapter examines the constructivist approach toward learning and proposes a function of learning effectiveness. This function explains the effectiveness of a distance learning program as a combination of the program goals, organizational characteristics, and level of interactivity. This chapter focuses on the variable level of interactivity and its associated criteria and processes needed to establish learning effectiveness. This variable is discussed in terms of the criteria that affect it and the relationships between the criteria. A model of these criteria is proposed for distance learning programs that utilize this approach. The importance of the level of interactivity is then examined using the model to explicate the constructs involved in achieving different levels of interactivity.

Two views which impact instructional design are symbol- processing and situated cognition. The dominant view has been the information processing approach which is the transmission of a fixed body of information to students from the teacher via external representation. Horton (1994) modified this approach by the addition of two additional factors: the student's context consisting of the environment, current situation, other sensory inputs; and mind, consisting of memories, associations, emotions, inference and reasoning, curiosity and interest. The approach in this chapter is to utilize the constructivist view.

1. Constructivism

The alternative approach, often called constructivism, consists of the learner actively constructing an internal representation of knowledge by interaction with the material to be learned.

Constructivism is a theory of learning , built on cognitivist foundations, that is presently receiving much attention as an alternative to the traditional view of knowledge. Constructivism presupposes three principles of learning:

1. Learning is a process of knowledge construction, not of absorbing and recording pieces of separate information.
2. Learning depends on previous knowledge as the principal means of constructing

new knowledge.

3. Learning is closely related to the situation or context in which it takes place.
(Resnick, 1989)

Constructivism lends itself to integration in the distance learning program in several ways. It:

- Encourages student autonomy and initiative.
- Uses raw data and primary sources, along with manipulative, interactive, and physical materials.
- Allows student responses to drive lessons, shift instructional strategies, and alter content.
- Encourages inquiry about student's understanding of concepts.
- Encourages students to engage in dialogue, both with the teacher and with one another.
- Seeks elaboration of students' initial responses.
- Provides time for students to construct relationships and create metaphors.
- Nurtures students' natural curiosity.

Distance learning must recreate the interaction between teachers and students and attempt to re-integrate it back into the instructional process. Several constructs must be present to achieve the high level of interaction required to facilitate an effective distance learning program. These constructs consist of:

- The technology applied to the course environment.
- The overall environment which enables students and instructors to function effectively to learn the subject matter.
- The effectiveness of the students and instructors that depends upon their initial skill level upon entering the course and their capacities to interact in the environment.
- The level of interactivity developed to achieve a mastery of the subject matter.

Students require these constructs to facilitate and assimilate new information to simple, pre-existing notions, and modify their understanding in light of new data. In the

process, their ideas gain in complexity and power, and with appropriate support provided by the presence of the constructs noted previously, students develop critical insight into how they think and what they know about the world as their understanding increases in depth and detail. Reibel (1994) states that, "Constructivist's propose the idea that the dominant metaphor in school should be the student-as-worker, and by the supporting idea that the student's work should engage complex information resources capable of sustaining authentic inquiry that is carefully conceived to help them integrate new acquirements into their corpus of knowledge/skills". As students engage in using the complex resources, the instructor is required to acquire new skills to support the students inquiry and use the new environment. Reibel (1994) proposes that:

The roles of teachers in these schools are reconfigured just as much as the curricular structures are. Whereas, in the comprehensive school, staff members have highly expertise-specific duties, in the school each and all have a collaborative responsibility for the whole. What's more, as the raw materials of the curriculum increasingly become electronic ones accessed via digital networks, the range of skills required of teachers is broadening rapidly. (Reibel, 1994)

2. Distance Learning Effectiveness Function

A function, described in a mathematical sense, is proposed to understand the effectiveness of a distance learning program. The effectiveness of a distance program is a result of the presence of three main variables. These three variables are the goals involved or implied in the distance learning program, the organizational characteristics, and the level of interactivity required to meet learning goals. In equation form the formula would be:

$$F(\text{Distance Learning Effectiveness}) = (\text{Goals, Organizational Characteristics, Interactivity})$$

This function of Distance Learning Effectiveness involves the interaction of the three variables in a mathematical sense. This interaction is dynamic, complex and consists of numerous intricate relationships which will not be explored in this paper. Distance Learning Effectiveness is measured by the process of feedback and how closely the

feedback correlates with the established course educational goals. From the function of Distance Learning Effectiveness, this paper will focus on one variable, interactivity, and use a model to describe the elements and processes involved to achieve it.

The issue of effectiveness in itself is elusive. The term is largely relative and means varying degrees of achievement, depending on whom one talks to. Effectiveness is a generic term which can be viewed from many angles. Linke et al. (1984: 19) relate effectiveness to “the levels of achievement of educational goals; it involves no connotation of value and no consideration of cost in effort required for the achievement.”

Robson (1996) proposes that “effectiveness can be examined with regard to the pedagogical processes used and desirable outcomes of learning associated with a particular course. Keegan (1990: 183) focuses on the quantity, quality and status of the learning, highlighting the need for careful thought being given to the meaning of effectiveness and its relationship to the notion of quality” (Robson, 1996).

Instructors using systems such as the Instructional Development and Evaluation Assessment (IDEA) determines effectiveness by their ability to meet course objectives. Students participating in these courses can rate their progress in the following areas:

- Gaining factual knowledge (terminology, classifications, methods, trends)
- Learning fundamental principles, or theories
- Applying course material to improve rational thinking, problem solving, and decision making
- Developing specific skills, competencies and points of view needed by professionals in the relevant job fields.
- Developing creative capacities
- Developing a sense of personal responsibility (self-reliance, self-discipline)
- Gaining a broader understanding and appreciation of intellectual-cultural activity
- Developing skill in expressing oneself orally or in writing
- Discovering the implications of the course material for understanding oneself (interests, talents, values, etc.). (Seldon, 1996)

Learning Effectiveness using the IDEA model is measured by how closely the students ratings and self-assessments approach the goals and instructor objectives set for the course. This feedback loop is set up between the students and instructor. The model proposed in this paper deals with the variable level of interactivity. This research will describe this variable, its sub-elements, and the interactions of the sub-elements.

a. Interactivity

The variable level of interactivity is defined as the total amount of verbal and non-verbal interaction that occurs between participating members of the distance learning course. The members influencing the level of interactivity are the instructor, the students, and the technology. The possible interactions are comprised of three types. They are:

- one-to-one
- one-to-many, and
- many-to-many.

The one-to-one route can be student-to-instructor or student-to-student. The interaction instance can involve exchanges of questions and answers communicated either verbally or in writing. Examples of one-to-one relationships are a student answering a directed question, an after-class exchange between the student and instructor, examinations, and exchanges between individual students. The one-to-many interaction is also two way and consists of questions, answers, and combined learning addressing many members of the class. Examples of this type of interactive exchange include a teacher lecturing students, a student performing a class demonstration, and an electronic audio/video medium providing the instruction. The many-to-many route is multi-directional, consisting of group interactions in which collaborative discussions may take place or brainstorming sessions to solve or present alternatives to proposed problems.

The level of interactivity is increased by the capability of the instructor and students to interact. The interactivity is affected by the relationships between the level of instructor effectiveness, the level of student effectiveness, the technology, and the environment. These reciprocal relations can produce the requisite level of interactivity

necessary for students to achieve specific learning goals. The criteria involved in such a system are explored in the next section.

3. Identification of Criteria

Willis (1992) describes the instructional development process for distance education as:

consisting of the customary stages of design, development, evaluation, and revision. Revision based on feedback from instructors, content specialists, and learners is an ongoing process. Provisions must be made for continually updating courses which depend on volatile information, to keep the subject matter current and relevant (Porter, 1994). (Sherry, 1996)

A successful design process is the culmination of a high level of collaboration between all of the proposed model's sub-elements that in turn create a strong possibility of interaction. These sub-elements in turn interact to bring about a level of interactivity that affects the distance learning program effectiveness. Hackman and Walker both agree that "When the system of conveyance allows interactivity and control, and when instructors are immediate and present, students learn more and are more satisfied with the experience regardless of the modality". (Hackman, Walker, 1994)

a. Environment

The environmental sub-element is the collection of physical attributes, embedded technology, and other assorted qualities that describe the functionality and surroundings of the distance learning classroom. From a systems point of view these variables combine and interact to establish one of the sub-elements influencing the instructor- student relationship which in turn defines the level of interactivity in the distance learning classroom. This classroom may be at home, at the workplace, a specialized classroom, or a conference room. The advances in telecommunications make the possibilities endless. A quality environment is characterized by a minimal amount of distraction, allowing the students and instructor to completely focus on the subject matter. An environment with the requisite level of technology and functionality enhances the overall level of learning effectiveness.

Technology is embedded in the environment. Flexibility must be built

into the technology. According to the Office of Technology Assessment (OTA) there is no one best use of technology; there is no one best way of teaching with technology. The OTA reports that "Flexibility should be encouraged, allowing teachers to develop their personal teaching approach utilizing the variety of options offered by technology". (US. Congress, 1988)

The success of technological flexibility is also supported in other studies. Sherry reports that "Millbank (1994) studied the effectiveness of a mix of audio plus video in corporate training. When he introduced real- time interactivity, the retention rate of the trainees was raised from about 20 percent (using ordinary classroom methods) to about 75 percent (p.75)". (Sherry, 1996)

Physical attributes of the classroom affect the environment also. In the interest of decreasing the distraction to students variables such as lighting and temperature should be kept in the comfortable range.

b. Student Effectiveness

Student effectiveness is the capability of the student to utilize the technology in the classroom and to interact fluently with the instructor to achieve the level of interactivity necessary for learning effectiveness. A student beginning a course must have the prerequisite tools and knowledge to attain the minimum skill level required to function in the course. These tools and knowledge include the motivation to conduct inquiry into the subject matter and the capability to operate the technology in order to explore the subject matter. Just as advanced subject courses require prerequisite courses to ensure a minimum knowledge level, so too must a student arrive in a distance learning environment with a prerequisite amount of intellectual and technological capacity. A student's effectiveness is influenced by: attendance, oral communication skills, written communication skills, attitudes, work habits, and preparation. A prepared student is more likely to learn more as he/she develops existing notions and views in a constructivist manner. Also, familiarity with the tools of the classroom enable the students to increase the rate of knowledge acquisition and proficiency to learn. Student progress is measured by various forms of feedback to the instructor.

c. Instructor Effectiveness

Instructor effectiveness is defined as the capability of the instructor to interact in the distance learning classroom given the influences of the students and the environment. An instructor who is at ease with the tools and technology present in the distance learning classroom utilizes those tools to provide visual stimulation, audio stimulation, and variety to the course. The tools can become a teaching multiplier and not a distraction and hindrance.

A new instructor not familiar with the tools finds his/her level of effectiveness diminished as he/she is forced to implement unfamiliar technology in a classroom environment to provide a meaningful course presentation. It is difficult to conceive of pedagogically sound ways to apply a technology when one is not familiar with it. This situation comes across to the students as a distraction as the unfamiliar instructor learns to manipulate the technological tools to provide the content of the course.

The instructor role in the distance learning classroom is markedly different from the traditional role. The instructor has to be able to adapt to the video and audio tools of the program. An instructor who is caring, confident, experienced, at ease with the equipment and uses the media creatively may be able to create the necessary level of interactivity with the students to provide an important element for successful distance learning (Sherry, 1994).

Production quality is another example of how the instructor role is changing in the distance learning classroom. In the video tele-education environment it is important to establish and create a perception of face-to-face and personable interaction. This interaction is important in helping to strengthen the Instructor/Student Process discussed later in the chapter. The instructors role involves helping to initiate interaction and using suitable methods of presentation in the distance learning environment to elevate the interaction to a satisfactory level to accomplish the course objectives. Studies conducted by Rice (1984) and Hackman & Walker (1994) have suggested that rapport with class peers seems to be important in a student's personal one-to-one development and that a reason for students resisting the tele-education environment may be the perceived lack of communication norms in a mediated context of close proximity.

Several researchers indicate that instructors develop interaction by “priming” the remote students before class (Biggs, 1994; Hackman & Walker, 1994; Suchan & Crawford, 1995). Priming is important to Instructor/Student effectiveness in establishing the process of interaction. Priming can be accomplished with humor, chatting before class, extensive use of student names, judicious use of exercises that promote interaction, calling on students specifically, inviting and recognizing their participation, and disclosing personal data.

d. Feedback

Feedback is an essential part of a distance education program. Feedback is defined to be a verbal or non-verbal form of input between members of the system used to validate the modification of knowledge and learning effectiveness of a distance learning program. A distance learning program should establish educational objectives as part of the process to determine the effectiveness of the program. Spiro, et.al (1995) suggest that any effective approach to instruction must simultaneously consider the following:

- the constructive nature of understanding
- the complex and ill-structured features of many, if not most, knowledge domains
- patterns of learning failure, and
- a theory of learning that addresses known patterns of learning failure.

Feedback supplies the reference points to identify changes in the knowledge domains and aids in the standardization of constructive learning as students navigate through the domain’s complex and ill-structured landscape.

Spiro sees various forms of conceptual complexity and case-to-case irregularity in knowledge domains (referred to collectively as ill-structuredness) as posing serious problems for traditional theories of learning and instruction. He describes cognitive and instructional neglect of problems with respect to content complexity and irregularity in patterns of knowledge as leading to learning failures that take common, predictable forms. These forms exhibit conceptual oversimplifications and the inability to apply knowledge to new cases (failures of transfer). Specifically, when first introducing a subject, teachers are

often satisfied if students can demonstrate a superficial awareness of key concepts and facts, as indicated by memory tests that require the student only to reproduce what was taught in roughly the way that it was taught. In an advanced learning environment where complex knowledge modification must take place, this diversity characteristic of ill-structured domains become a serious problem. It is through the proper use of feedback that diversity is minimized to help achieve conceptual mastery and consistent constructs of the subject matter. It is then, when conceptual mastery and flexible knowledge application become paramount goals, that feedback serves to facilitate the educational process and contribute to the learning effectiveness of the distance learning program. This is analogous to a Calculus instructor teaching the concept of integration. Students are presumed to have had instruction in advanced Algebra, and pre-Calculus courses to provide the building blocks, definitions and concepts necessary for expansion of the student's knowledge domain when introduced to integration. These concepts might include the idea of variables, standard notation, and rules for mathematical manipulation and representation. In the Calculus course, students are expected to understand and manipulate these rules in a standard manner. The Calculus instructor would have a much harder time teaching if each student treated the mathematical operations differently, because each student had a different method for integration. The feedback in the Calculus course is the proper manipulation of the assigned homework/test problem to obtain the correct answer. This is used as evidence that the student comprehends the concept in accordance with the accepted standard of the subject of integration.

The instructor should examine course feedback on a periodic basis to determine the congruency of the feedback versus the objectives. Feedback is a two-way process that connects students and instructors. Feedback validates whether the course objectives have been met. The distance learning model illustrates feedback as a two-way process that each member (students and instructors) use to establish a measure of learning effectiveness for the course.

Feedback occurs in various forms to be utilized by the instructor and students. Verbal feedback can be composed of suggestions for course modification,

directives for course changes, oral recitations, reading comprehension (students practicing a foreign language), and general conversations about course likes and dislikes.

Non-verbal feedback forms are examinations, questionnaires, and student opinion forms. An important form of feedback that can be both verbal and non-verbal is reflection. A national goal of the Australian schooling system is to bring students to the point where they become independent learners. An important aspect of determining whether the goal being achieved is to use feedback. In considering the effectiveness of a program, it is of interest to investigate the steps taken to encourage responsibility for independent learning among the students. Robson (1996) refers to reflection as part of the feedback mechanism and its importance to the learning process. He cites research from Candy, Harri-Augstein and Thomas (1985):

that refer to commentary on the learning process, personal support of the student's reflection and bench marks for students to evaluate their learning competence. This is reflection as part of the learning process of a student within a course. The provision of the opportunity for such reflection would normally be considered in the evaluation of a course. (Robson, 1996)

Another important reason to represent feedback in any model is the abundance of perspectives on measures of effectiveness in the literature. This abundance makes any attempt to evaluate effectiveness a multi-dimensional effort. Therefore, the student attitudes towards the teaching and learning situation are important in evaluating effectiveness of a distance learning course.

B. INTRA-ELEMENT PROCESSES

This section examines the processes among the elements of the proposed model starting with technology and the environment and then moving through the model to build the process level of interactivity.

1. Technology-Environmental Process

Technology interacts with the environment to enhance environmental capability and flexibility. Technology contributes to the capability of the environment through added options for students/instructors. Technology such as audio/video capability in a VTE setting gives the instructor access to different instructive views and the capability to present

these views which aids students in the formation or modification of ideas. Technology properly implemented in the environment provides inter-connectivity for students that allows them to receive and complete assignments, collaborate with students in distant locations on projects, and interact with teachers and outside experts to receive help, hints, and critiques. A "Report on the Effectiveness of Technology in Schools 1990-1992" conducted by Interactive Educational Systems Design concluded that "courses for which computer-based networks were used increased student-student and student-teacher interaction, increased student-teacher interaction with lower-performing students, and did not decrease the traditional forms of communications used"(Software Publishers Association, 1993). An effective application of technology in the instructional environment can motivate teachers and students in a distance learning program by encouraging them to expand their knowledge concepts and accept technology as a useful tool that aids educational inquiry. Technology enables the environment to provide support for the learning process.

2. Environmental- Student/Instructor Effectiveness Process

The environment impacts student and teacher effectiveness through physical and psychological aspects. Physical aspects might include the lighting, the functionality of the technology within the environment, access to, and ease of use of the environment. The psychological aspects include student and instructor perception about the course itself, about each other, the subject matter, and mental distractions such as sickness and stress. Consideration of these aspects in the environment in which the students and teacher work is necessary for analyzing the interdependence of the learning and teaching and for relating the organization and practices of instruction with the immediate and long-term responses of the students. The totality of the physical and psychological factors form an environmental outcome that influences attitude outcomes and provide motivations for teachers and students alike. Motivated teachers and students, presented with an effective environment that displays the positive benefits of the distance learning course, are more likely to be successful in the course. An environment that is effective provides the necessary functionality to stimulate and support interaction between the students, between the students and instructors to achieve the learning objectives of the course.

3. Student and Instructor Effectiveness Process

The process relationship between Student Effectiveness and Instructor Effectiveness is bi-directional. The environmental outcomes provide the functional support for the Student and Instructor relationship. The process starts with both sides willing to explore and manipulate ideas. Students and instructors work to recognize each others class mannerisms, body language, and interactive skills necessary to conduct the course. The students work to utilize the complex information resources, such as the Internet, data libraries, email, and software programs that may be course related, all of which are capable of sustaining inquiry. The relationship gains familiarity and intensity as the course progresses with the students integrating new ideas and concepts into their collection of knowledge and skills.

4. Feedback Process

Feedback is a bi-directional process as both students and instructors seek to validate the learning process. The feedback process consists of both teachers and students providing reciprocal responses (verbal and non-verbal) about their interests, understanding of the subject matter, and feelings regarding the manner of course presentation. This process develops during course presentation on a real-time basis, with the instructor reading student responses by observing the students body language, mannerisms, and presenting verbal and written inquiry to obtain guidance on course progression. This process helps clarify course expectations and goals between students and instructors while building the strength of the instructor effectiveness/student effectiveness sub-system. This process is repeatedly validated by each course member against the goals and objectives for the course to determine the effectiveness of the learning process.

5. Student/Instructor Effectiveness- Interactivity Process

The underlying framework to achieve a level of interactivity is a combination of the elements and processes discussed previously. Each element and its associated process serve to strengthen the elements and processes downstream. This dynamic interaction culminates in a level of interactivity to establish a viable part of the learning effectiveness function. Using the feedback process to determine the position of the students in the ill-structured domain, the instructor can readily vary the rate and nature of instruction to

adjust course direction and advancement. The needed adjustments can be implemented by comparison of the course and instructor objectives to the current level of student mastery of the subject matter. The instructor can then couple this observation with changes in interactions with the students to redirect the course and minimize learning failures. This re-examination of the student/instructor effectiveness-interactivity process and directing changes by observing feedback affect the overall level of interactivity present in the distance learning course.

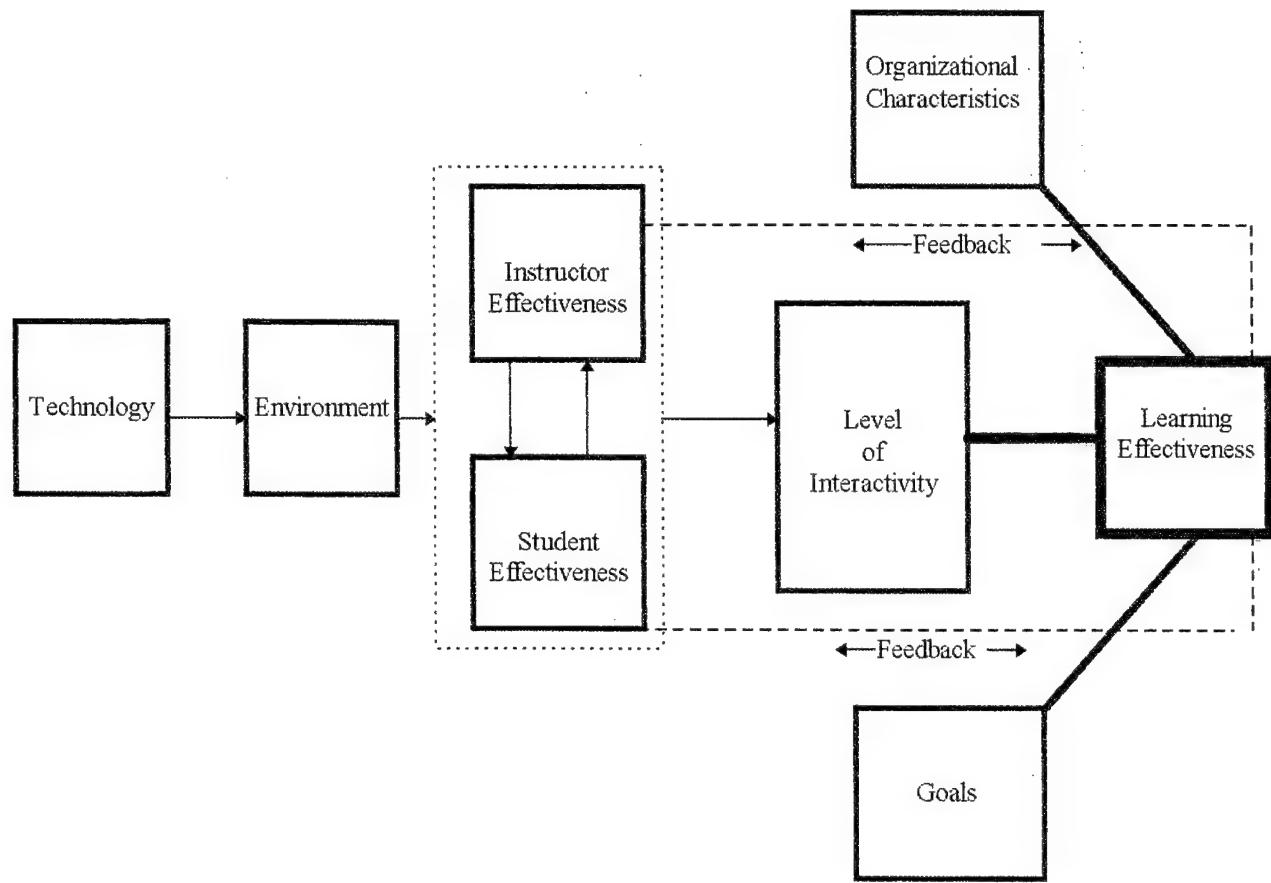


Figure 1. A Learning Effectiveness Model For Distance Learning

IV. EDUCATIONAL MODEL APPLICATIONS

Chapter IV illustrates how the distance learning model developed in the previous chapter can be applied to three courses taught at the Naval Postgraduate School. The School utilizes two distance learning classrooms to provide instruction in a number of courses including software engineering, digital signal processing and communications, information technology management, fundamental management courses, and short courses in executive management education. Three of these courses, Economic Evaluation of Information Systems (IS 3171), Public Policy Processes: Federal Budgeting (MN 3172), and Organization and Management (MN 3105), are used to demonstrate the model's predictive capability and flexibility in instructional environments where the learning outcomes and objectives among courses are different.

It should be noted that the three courses discussed in this chapter have distinctly different learning outcomes. This was done to expose the reader to the flexibility of the model in evaluating different courses. Professor Bui's course, IS 3171, is designed to develop specific skills by applying course material to improve rational thinking, problem solving, and decision making. The students utilize theory and its application to practical work related problems. Professor Doyle's course, MN 3172, provides students with factual knowledge about the federal budgeting process. The students learn fundamental principles, theories, terminology, and budgeting trends. Professor Crawford's course, MN 3105, develops the creative capacities of the students, gives students a knowledge of key concepts from management theory, organization theory, organizational behavior and development. The integrated application of these concepts is emphasized to provide experience in analyzing management situations.

Each example application provides a brief background description of the course, and then examines the course in terms of the distance learning model. This examination of the model will start with the technology in the classroom, then proceed to the constructs in a left-to-right manner ending with learning effectiveness.

The discussion of these distance learning courses is based on face-to-face interviews of the instructors, examination of student opinion forms (SOF), visits to the NPS VTC facilities in Monterey, and review of course materials. The chapter concludes with a comparison of the courses.

A. EXAMPLE ONE OF THE MODEL'S APPLICATION

1. Course Background

The first course examined is a System's Management course, Economic Evaluation of Information Systems (IS 3171) taught by Professor Bui. The course is conducted via video teleconferencing with students at the Naval Research and Development (NRaD) group in San Diego, California. The objective of the course is to provide the students with managerial economics concepts and processes to evaluate information technology and to utilize decision making criteria to solve practical, common, work-related problems. Topics covered in the class include: Cost-benefit analysis, cost-effectiveness analysis, the value and cost of information, life-cycle management, risk assessment and mitigation, group decision and negotiation, functional economic analysis, multiple criteria decision making, software cost estimation, selection of computer systems, and business process improvement/re-engineering. The course is tailored to the needs of NRaD and provides graduate education to a class of senior personnel whose offices are approximately 45 minutes away by car from the nearest University that could offer a similar program of study.

Students taking the course from NRaD are a homogenous group consisting of 28 middle level to senior software engineers and project managers, usually GS 11 and GS 12 level personnel. The course is indispensable for students in that successful completion impacts their promotability and career progression at NRaD. The work experience, educational background, and age of these civilian students are also very similar. Most of the students have undergraduate degrees in computer science or an engineering discipline.

2. Model Application to the Course

a. *Technology*

The technology used at NPS for Systems Management courses is housed in two dedicated classrooms. The equipment layout is very similar in both rooms. All three courses discussed in this chapter use the same VTC setup to conduct the course from NPS. Equipment consists of a PictureTel system that is Integrated Services Digital Network (ISDN) based, three 40 inch screen video monitors, a visualizer, two video cassette recorders for playback and recording, a fax machine, an electronic whiteboard, and a scan converter for computer based media.

The PictureTel model 4000 videoconferencing system uses three ISDN Basic Rate Interface (BRI) to provide two-way interactive audio and video between the remote site and the NPS classroom. Four sites including NPS can be linked simultaneously at transmission speeds of 336 kbps. The classroom also allows access to the Internet, file transfer, electronic mail (email) and an online library.

The NRaD remote classroom is equipped with a similar video teleconferencing system supplemented by an electronic whiteboard and a computer projector. A 40-inch monitor was used to display the instructor from NPS, and the camera can be remotely controlled by the instructor to scan the remote classroom.

The audio system at both NRaD and NPS consists of individual microphones that can be turned on and off at each student's desk. The instructor can speak into a stationary microphone or has a wired microphone with a clasp to attach to clothing. The system does suffer from some noise intrusion or feedback to the remote site as the instructor teaches from the NPS site. The sensitivity of the system picks up background noises such as coughing and whispers that may interfere with the primary information passed over the audio channel. This noise co-mingled with the instructor's voice tends to slightly degrade the audio quality that arrives at the remote site. Other factors can degrade the audio quality such as the speaker's speech patterns, accent, and enunciation. This audio degradation has the potential to interfere with interactivity as students and instructor waste time repeating themselves due to reduced audio

comprehension at the remote site. This arrangement, however, was not troublesome for this course because the instructor only had students at the remote site and the nature of the course syllabus and course assignments placed responsibility for teaching a large number of class sessions with the students.

The classroom setup and available technology proved the feasibility and reliability of conducting a course via video teleconferencing. Access to the Internet and email enhanced the overall usefulness and capability of the course by providing extensive resources for the students to explore and construct their topics and term papers. These capabilities serve as supplementary communications channels that can enhance the quality of the course and participants accessibility to each other and electronic resources.

The classroom technology allows various modes of interaction on a one-to-one, one-to-many, and many-to-many scale among students and instructors. The instructor can use the video screen to observe students as they participate in discussions and give presentations. The two-way audio allows real time communication between students and between the students and the instructor as the class seeks clarification of issues or answers to questions. Both the audio and video capability provide a form of one-way feedback to the course instructor about how the students are progressing in the educational environment by giving cues to the instructor about a students' motivation and understanding of the subject domain. Email as a supplementary communications channel can support the one-to-one, one-to-many, and many-to-many interactions. The Internet is another multi-interaction supplementary communications channel that provides access to electronic resources by responding to specific inputs.

The technology provided at both the NPS and the remote site increased the capabilities of the environment by enriching the tools available for students to conduct inquiry, making resource access convenient, providing a main and supplementary communications channels, and providing video capability that operates in real time.

b. Environment

Several factors contributed to the reinforcement and preparation of the environment. Both the instructor and students were technically literate in that both had exposure to complex computer systems and the problems inherent to their development

and use. The instructor postulated that any inconvenience caused by the limitations of the technology was outweighed by the fact that the students felt privileged to have access to a high quality facility and the faculty of NPS. The result was that both parties were tolerant towards the technological limitations, such as video resolution and clarity of the audio channel, and viewed VTC as a worthwhile tool to provide meaningful instruction and education.

An interesting aspect of this course was that the students chose a less capable classroom located within their office over one that was newer and had moderately better technology. The newer classroom was located approximately 100 yards away from the students office building. The students chose to remain within their building because of the convenience and proximity to their work facility. This seems to suggest evidence that factors that provide convenience within the environment, such as proximity to work and the classroom, are important to student/instructor satisfaction and reinforce the distance learning environment.

The Internet was also utilized to give the students convenient access to the course material. The course syllabus was placed on a homepage that delineated the organization of the course, provided lecture notes and transparencies available for downloading, and instructions for writing the term paper. The instructor also made available site licensed software to the students using password verification to accomplish assignments. The availability of the software increased convenience for the students and provided a tool to aid the accomplishment of homework exercises and enhance the professional appearance of the course work.

The course was scheduled to meet twice a week between 4:00 p.m. and 6:00 p.m. because the students were part-time and continued to work normal hours at NRaD. This schedule made the course convenient and available to all interested NRaD personnel. An environment that is accessible at a time convenient to the students and instructor can be a more effective tool to aid learning. The issue of course scheduling is a source of dissatisfaction for the students in the next example application of the model.

The technological disposition of the instructor and the students, the course location, course organization, availability of resources and materials, and course schedule

combined to create a distance learning environment capable of supporting motivated students in furthering their education and adding to their educational experiences.

c. The Instructor Effectiveness Role

The technology present in the course combined with the relative convenience of the environment provided the tools and capability required to achieve the learning objectives of the course. The instructor was familiar with the limitations of the technology (audio and visual quality) and modified his course syllabus to minimize distractions caused by poor video resolution and audio clarity while increasing the instructor/student effectiveness in the classroom. The syllabus modification assigned most of the responsibility for instruction to the students. The instructor conducted the first four lectures and assigned topic responsibilities for the follow-on lectures to the students. This accomplished two goals for the instructor.

The first goal overcame the limitation of the audio quality present within the course. The instructor has a heavy accent that requires focused concentration for comprehension. The instructor did not want to waste time restating questions and clarifying his lecture notes because students might have problems understanding him clearly over the audio channel. The accent was not an issue in the four face-to-face lectures conducted at the beginning of the course because there was not degradation of the instructor's voice and he took care to enunciate clearly. By assigning topics to students, the instructor overcame the problem by reconfiguring his role from lecturer to that of a facilitator.

The second goal was to encourage the students to take charge of their education and conduct authentic inquiry into the course topics. The instructor felt this was a satisfactory means to increase student effectiveness and build face-to-face interaction between the students and VTC interaction among the students and the instructor.

The instructor also utilized email exchanges with the remote site to develop an interpersonal relationship with the class through instructor-to-student interaction and to encourage the students to discuss problems and other aspects of the course. These exchanges provided opportunity for the instructor to indoctrinate students to a shared vision of teaching, increase students motivation to modify, construct, and expand their

knowledge, establish a close rapport with prospective students, and adapt his teaching styles to suit the technology.

d. The Student Effectiveness Role

Students participating in the course were provided with an effective motivator to succeed in completing the course. The students work in a highly technical field which requires advanced education for them to be successful. The course offered by NPS is crucial to obtaining a master's degree which significantly improves a student's opportunities for promotion. The students recognize the advantages of participation in a high quality tailored course taught via VTC over one that involves 45 minutes of travel and is more generic than the one taught by NPS.

The technical background of the students participating in the course helped to mold the disposition of the students toward accepting a technological oriented course. The students were used to complex computer systems and were not intimidated or rebuffed by the technology used in the VTC or its limitations. The students readily accepted the VTC environment and quickly settled into utilizing it as a tool for aiding their education.

Students were formed in two-person teams to co-teach the course with the instructor. Each team was assigned a class session and provided with lecture materials and readings to make a presentation. The student teams made heavy use of the email capabilities to interact with the instructor and prepare their class presentations. Capabilities such as email served as supplementary communications channels that complemented the main audio channel. These supplementary channels provided other available means to conduct course business and helped students and instructors pass course information, attach files, and answer questions that may be raised outside of the class time. The presence of supplementary communication channels expanded the communications capability of the course by giving the participants another useful tool with which to interact.

e. Instructor/Student Interaction

The instructor initiated the building blocks for interaction in the course by sending a welcome email to each participant stating the course objectives and expectations ten days prior to the first class meeting. The instructor also exchanged phone conversation and email with the resident program coordinator. This preparation and first-hand

knowledge of the remote site helped the instructor to formulate the course material and adapt his teaching methods to build and support interaction in the course. The instructor also utilized this time in face-to-face interaction to allow the students to prepare their presentations and get used to his accent.

Both the teacher and student familiarity with the technology contributed to overcoming any intimidation or trepidation in using VTC. Email was readily accepted by both sides in conducting course business and came to be heavily relied upon in passing information on the way the class was conducted, answering questions regarding class material and issues, and obtaining feedback. Quick response to email was perceived by the students and the instructor to be essential in maintaining a high degree of instructor-to-student interaction. Neither the instructor nor students felt overwhelmed with email. The volume of email was acceptable to both sides and did not overwhelm either the instructor or students. The automatic features of email made addressing trivial, and most found typing a quick message to be just as satisfactory as a phone call.

Interaction between students was developed by modifying the course structure to allow the students to conduct course sessions that they prepared as two-person teams. This structure allowed students to “take charge” of their learning experiences and encouraged students to share knowledge, experiences, and ideas during class sessions. Feedback from the students with regard to the presentation assignments was positive in that the students reported that having to do the presentation forced them to dig into the topic more than they would have otherwise. This mode of inquiry was effective in gaining knowledge about the subject.

f. The Feedback Process

Feedback served as an important mechanism to the instructor in that it provided assurance that course objectives were being achieved and that a sufficient level of interaction between students and between the students and instructor was developing and being maintained in the course. The instructor used email to answer questions, provide guidance to students on presentations, review student input, and conduct course business. The instructor sent feedback, in the form of constructive criticisms, to each student team immediately after each presentation via email. The instructor chose email to provide

criticism because of its more private nature in that only the team members would see it. The homework and term paper assigned in the course provided the instructor with written verification that the students could demonstrate and apply the concepts and topics conducted in the course. Another benefit of having the students conduct presentations allowed the instructor to listen to verbal feedback and appraise the students understanding and breadth of knowledge.

g. Level of Interactivity

The level of interactivity in the course was supported by the technology, the environment, and the instructor/student effectiveness. These elements again provide the framework and building blocks to support and maintain interactivity in a course.

The technology in the environment provides reliable two-way audio and visual means to conduct communications. Despite the limitations of the video resolution and the audio clarity, the students accomplished the course learning objectives and the instructional techniques were modified to support the course. The extensive use of supplementary communications channel to enhance the regular channel and provide a reliable and convenient mechanism for feedback also helped assist course interactivity.

The environment at the NRaD site was convenient to use, accessible to students, and relatively complete with the tools necessary to conduct the course. The environment supported the instructor and student effectiveness. Both the instructor and students were comfortable and familiar with the technology, recognized its video and audio limitations, and readily accepted it as a tool for learning. This acceptance made both the instructor and students more tolerant of the technology implemented in the classroom. The supplementary communications channels were used freely and provided a feedback mechanism for both the students and the instructor.

The result was a distance learning course that contained the necessary constructs that interacted and seemed to meet the instructor and students' expectations. The process interactions among the constructs maintained an adequate level of interactivity that allowed the course learning objectives to be achieved.

B. EXAMPLE TWO OF THE MODEL'S APPLICATION

1. Course Background

The second course examined was MN 3172, Public Policy Processes: Federal Budgeting. The course, taught by Professor Doyle, uses a descriptive and analytical approach to provide students with the background of the federal budget process and to develop a critical perspective and understanding of the process so they can participate effectively in it. Professor Doyle has taught the course 16 times.

The course, taught in the summer of 1996, consisted of 15 military students in the NPS classroom and 11 students, mostly military, at the remote site in San Diego at the North Island Naval Air Station. Almost all students were active duty Naval Officers.

There were differences in the student groups. The NPS student is a military officer whose primary duty and responsibility is to attend courses and complete a curriculum leading to a subspecialty and a master's degree. Most classes for these full-time students are scheduled from 8:00 until 5:00 Monday through Friday. The remote group of students consisted of helicopter pilots whose primary duty was to carry out the assigned orders and missions while attached to a squadron at North Island Naval Air Station. Most of these students are taking the course on a part-time basis; consequently, the course must be scheduled after working hours. Also, the course is not their primary mission, and it competes with other requirements (family, work, deployment, etc.). This course linked two disparate groups, part-time and full-time students.

2. Model Application to the Course

a. Technology

The technological layout of the equipment was a problem for the course instructor. The instructor is surrounded by the equipment in a way that restricts his ability to move about freely while conducting class. Professor Doyle is accustomed to moving about the classroom as he conducts a class session. The equipment layout of the VTC classroom places all equipment in close proximity to the instructor so that it can be accessed quickly and conveniently as needed during a class.

Another problem for the course was the capability of the microphones. The remote site technology utilized a NPS compatible setup with a 40 inch monitor, and individual microphones for the students. The students at the remote site had to turn their microphones off to avoid feedback to the NPS classroom. This impaired the ability of the students at the remote site to participate freely during the course. Professor Doyle felt this contributed to significant delay. A question asked from the NPS audience would require him to stop, turn on the microphone, repeat the question to the remote audience, and turn the microphones off once the exchange was complete. If the question originated from the remote site, the instructor was forced to respond to a visual cue, such as a raised hand, and allow time for the remote audience to turn on their microphones. This problem was not encountered in the first course example because the instructor did not conduct the course with both local and remote audiences.

b. Environment

The two problems with the technology contributed in a negative manner to the environment of the course classroom. An environmental problem noted by the instructor was that to use the technology effectively in the videotraining environment required the instructor to add extra tasking in addition to normal tasks accomplished while conducting the course. This extra tasking included stopping to raise or lower equipment, stopping and starting various forms of media, correcting audio problems, changing camera angles, and shifting from camera to whiteboard or to the document camera. Most instructors unfamiliar with VTC cannot easily handle the extra tasking while conducting the course and still provide a smooth and focused course session. The result is a series of distractions that detract from the content of the subject matter being presented. These distractions significantly impact not only the students at both the remote and local sites but also the instructor. The problem with the tasking was partly solved by utilizing a full time technician to operate the equipment. This arrangement allowed the instructor to remain focused on the course content.

The distance learning environment also presented problems with a timely and cost effective means to deliver visual aids. The instructor relies heavily on charts, graphs, and other visual aids to reinforce the concepts presented in the federal budget

course. These visual aids are updated frequently and sometimes on short notice to keep the course content current and relevant. The instructor experienced problems with presenting a readable visual aid to the remote audience. To present a readable chart or graph to the remote audience required the instructor to fax a legible copy to the remote site in San Diego and have it reproduced at the site for the students. The frequent inventory turnover prevented the instructor from pre-mailing course packages to all the students with complete sets of the charts and graphs.

Course timing was also an environmental issue in this course. The students in San Diego were only part time; they had to take the course at a time that did not interfere with their normal jobs. This necessitated scheduling the course at a late time during the day. NPS students are full time students and this course schedule required them to endure a long day of class with an inordinately long break while waiting to attend the budget class. This problem was not encountered in the other two courses because they had no NPS students in the courses.

Another timing problem was mailing materials such as syllabus and exams and having them arrive on time at the remote site. This problem culminated with the mailing of the final exams. They arrived at NPS almost three weeks late and required the instructor to delay course grades. This provided an inconvenience to both the local students and remote students.

c. The Instructor Effectiveness Role

Technology is integrated into the environment and this construct impacts the instructor/student effectiveness system. The instructor used several techniques to prepare for the class and increase his effectiveness. Preparation for teaching in a distance learning course included familiarization with the classroom, the equipment, and advance practice in using the technology. This gave the instructor practice in integrating the technology and environmental requirements into his lecture and provided insight into the characteristic problems of distance learning. This advance knowledge and experience provided the instructor with a measure of confidence when teaching the course via VTC. This increased technical proficiency also helped him identify the unique problems associated with extra tasking and minimize surprises.

The instructor traveled to San Diego to observe the remote site and acquire an appreciation for the students. This effort increased his understanding of the video, audio, and interactivity difficulties associated with teaching the course and provided background on the type of student enrolled in the class. The instructor used the first two class periods to provide face-to-face instruction to the students in San Diego.

This priming familiarized the instructor with the students' faces, names, and other class mannerisms while providing the students opportunity to become comfortable in the classroom environment. After the introductory face-to-face classes, the instructor returned to NPS to conduct the class via VTC.

The portion of the course conducted via VTC encountered limitations with the audio clarity of the microphones. The instructor felt that his and the student's effectiveness was hampered largely by the problem with the microphones. The audio quality problem required the instructor to conduct the class with a clearly enunciated, and controlled voice in order to be understood at the remote site. The instructor adopted this method to reduce time spent repeating statements and questions. This method of speaking became more automatic as the course progressed. It hampered attempts to get the remote site and NPS students to interact and exchange relevant experiences that could have added to course satisfaction and learning. The problem also forced the instructor to utilize most of the class time lecturing instead of provoking and guiding class discussions.

d. The Student Effectiveness Role

The student effectiveness is based on the instructor's opinion, the student opinion forms (SOF), and the background of the students. The capacity of the students to take part in discussions, ask questions, and access resources in the classroom environment is a crucial part of the students' ability to construct and modify their knowledge domain in the distance learning course.

The remote students' background seemed to affect their ability to participate in the class. Their background differed from the local NPS students in that their graduate education usually consisted of completion of low quality night school classes in the pursuit of a graduate degree. The remote students were only part time and all had full time day jobs and participated in the course after work. The instructor felt that the NPS

students were better prepared for the course due to the fact that they were full time and acclimated to the school environment. He also felt that the remote students at times were intimidated and put off with the nature of the course. The remote students also tended to exhibit signs of uninterest and boredom more often than the local students. The instructor felt this was due to fatigue after working a full day and then attending class.

The course materials provided to the students seemed to be problematic also. Student participation and interest in the course depends somewhat on the materials assigned and the ease with which these materials can be accessed, studied, and questioned/commented upon. With the course heavily dependent on charts and graphs and other visual aids, the students had to spend some time searching their packets for the proper chart or wait while a new visual aid was being reproduced. The remote students also had to wait longer for materials that had to be mailed to the remote site.

e. Instructor/Student Interaction

Interactions between the students, instructor to students, and students to instructor, were largely hampered by the technological problem of the microphones and the impact on the environment. This environment restricted the interaction among the course participants. The classroom situation that evolved as a result was one in which the instructor had to rely on visual cues from the remote site and adapt the instruction techniques, such as stopping to repeat questions to the remote audience, clear enunciation, and relying on lecture and discussion during the course.

The instructor felt that the audio situation forced the students to act a two independent groups instead of one cohesive body that exchanged questions, comments, and experiences. He also felt that the maximum educational experience would have been accomplished had the two groups been able to participate in discussion and exchange experiences.

The problem also seemed to place a gulf between the remote students and the instructor. The instructor collected SOF data and analyzed the results. Three relevant questions were examined by the instructor. The results are based on students assigning numbers corresponding to relative satisfaction about aspects of the course. The numbers vary from one to five and correspond with: strongly disagree, disagree, no strong opinion,

agree, and strongly agree for question number six on the SOF. For questions 12 and 13 on the SOF the numbers one to five correspond with: poor, fair, above average, excellent, and outstanding. The three questions are:

- 6. *I felt free to ask questions...*
- 12. *Overall, I would rate this instructor...*
- 13. *Overall, I would rate this course...*

The instructor compared the SOF averages from the previous 16 segments of the course that were taught from 1990 to 1996, the 1996 NPS student responses, and the 1996 remote student responses. The previous 16 segments did not utilize distance learning.

The results are indicated in Table 1 below.

	Question 6	Question 12	Question 13
1990-1996 SOF	4.8	4.8	4.6
avg.			
NPS D.L. SOF avg.	4.4	4.8	4.8
San Diego D.L.	4.1	4.6	4.4
SOF avg.			

Table 1. SOF Averages for MN 3172

The results indicate that overall the remote students in San Diego registered lower levels of approval on all three questions. Question six has the most pronounced difference, with both remote and onsite student SOF averages below the past average. The lower averages for the San Diego site could be partly attributable to the microphone problem which led to less discussion and limited.

f. The Feedback Process

The course did not appear to utilize a strong feedback mechanism to support the instructor in validating that the learning objectives were being achieved. The lack of use of real-time feedback appeared to handicap the process of examining the student achievements and performance, and their timely comparison to the learning objectives. The slow rate of feedback supplied to the instructor inhibited the identification

and adjustment of course structure and instructional technique. The main feedback mechanism utilized was the SOFs filled out by the students at the end of the course. Other feedback types consisted of using the two written exams to verify student comprehension and email exchanges between the section leader at the remote site and the instructor.

g. Level of Interactivity

We have examined the course example in terms of the distance learning effectiveness model. The level of interactivity was inhibited in this course as a direct cause of the limitations of the technology. The microphone problem impacted the environment which in turn impacted the relationship between the students and the instructor. The student and instructor effectiveness was also impacted by a number of variables already discussed. This created an overall level of interactivity that was less than desired and seems to be indicated by the SOFs returned by the remote students.

The level of effectiveness in this course seemed to be adequate to accomplish the learning objectives. The learning objectives were fairly simple, however, requiring students to gain understanding of the budgeting process through examination of examples and experiences. If the knowledge domain were more complex and required the students to demonstrate application of knowledge and tools to solve advanced problems and applications, the level of interaction achieved might be inadequate.

C. EXAMPLE THREE OF THE MODEL'S APPLICATION

1. Course Background

The third course examined is Organization and Management (MN 3105) and is team taught by Professors Crawford and Edwards, who are using VTC for the first time. The interview for the course observations was conducted with Professor Crawford. The course examines the complexity of organizations and gives students managerial skills to add to their decision-making and problem solving expertise. The course's learning objectives seek to increase student awareness of the complexity of organizations, increase student awareness of their personal approach to management, increase student's ability to conduct

critical analyses of organizational and managerial strategies, enhance students' effective management styles, and broaden perspectives on organizations.

The course encourages and stresses the importance of class participation in order that students may share relevant managerial experiences and provide cognitive demonstration of theory. Class participation involves demonstration of a knowledge of class materials, speaking intelligently about subject matter rather than just adding comments, and presenting logical analysis of case studies. Additional written work is required in the form of a personal case study, an analysis of leadership based on a written autobiography or biography of a military leader, and a research paper based on a management or leadership topic. The course requires outside reading and class preparation commensurate with that of an NPS class.

The students in MN 3172 are mostly Navy helicopter pilots based at the North Island Naval Air Station in San Diego. The students are part time in that they fulfill squadron tasking during the day and attend the course at the remote classroom from 4:00 p.m. until 6:00 p.m. twice weekly. There are eight students participating in the course including one civilian. Originally the course had 14, but four students dropped out because of time constraints, and two were deployed. The course only consists of the remote class in San Diego.

2. Model Application to the Course

a. *Technology*

The course sessions do not depend on the heavy use of visual media such as charts, slides, or graphs. Instead, discussions of the written material, examinations of mini-cases, and experiences are analyzed to develop and sharpen the cognitive and analytical skills of the students. The instructor did not experience problems with the audio technology (microphones) in this course because there was only one audience, the remote site.

The technology was adequate to meet the course's learning objectives, which did not demand a high amount of visual media usage, and supplied sufficient communications capability to support the discussions and analysis necessary to achieve the

objectives. A sufficient communications capability depends upon the learning outcomes for the course. Some courses may require heavy use of visual and interactive media requiring high bandwidth, high resolution video, and enhanced audio capabilities to achieve the transfer of the subject matter. Other courses such as this one that utilize student discussion and analysis as a major instructional technique only require bandwidth capable of supporting two-way audio for some student to instructor discussion and a lower amount of video resolution. These courses are not as demanding of the technology and require less functionality to accomplish their learning outcomes.

b. Environment

The remote class environment and VTC instructor environment consisted of the same technology and facilities discussed in the second course application of the model. The remote classroom provided a large screen video monitor, individual microphones, copy machines, and fax machines to the students. The site did not have Internet and email access available for the students. Email was sent via the section leaders home computer and the instructor. Despite these shortcomings the environment was adequate in supporting discussion and case analysis by the students and completion of the assigned course material.

c. The Instructor Effectiveness Role

The course preparations for the instructor included travel to the remote site to observe and get acquainted with the students. This face-to-face visit enabled the instructor to establish name and face recognition and answer student's questions about the course. The instructor uses several other methods to prime the students and build the level of interaction. These methods not only included the visit to the site but also consisted of:

- using a particularly unique instance of management or controversial idea to provoke student reaction and discussion.
- using "cold calls" to directly address individual students by name and solicit their responses and opinions concerning course material.
- constructing a seating chart to help with name and face associations.
- employing class exercises that encourage cooperative discussions and

- active inquiry between students.
- changing activities frequently to maintain student interest and stimulate inquiry and ideas.

These combination of methods clarify the course structure and gave the instructor a toolkit that effectively controls course direction and the time spent developing each area of subject matter that is addressed. The instructor states that course sessions are dynamic, interesting, and completely captivate the students' attention.

d. The Student Effectiveness Role

Students in the course are navy helicopter pilots using off duty hours in the afternoons to work on achieving a master's degree. The factor of motivation, while present, does not seem to be as intense as the NRaD students previously discussed. The achievement of a master's degree is desirable but not an absolute must at this point in these students' careers.

A factor that seemed to affect student effectiveness in this course and impact motivation is the course workload. The workload is that of a normal class load for an NPS student. The fact that these students are part-time and have full daytime jobs has led to four attrites from the course due to the competing time demands of the course, home, and work. Two other students were deployed leaving a total of eight students enrolled in the course. Ironically, the reduction in the number of students could have increased the interest and the motivation of those remaining. The instructor is able to devote a larger portion of personal time and attention to each student during each class session. An instructor has an easier task of addressing a smaller number of students.

Another motivational factor that generates active participation and inquiry from the students is the fact that a substantial portion (15 percent) of their course grade depends upon their degree of class participation. The students respond with interest in fulfilling the grade requirement and participating in meaningful discussion.

The students past experiences in management situations seems to be particularly helpful in this course. These experiences are shared, discussed, and related to course material as students develop the analysis skills and methods required of management

of complex organizations. These experiences form a common bond for the students to identify with and ease the initiation and sustainment of discussion in the course.

e. Instructor/Student Interaction

Interaction between the students and between the students and instructors is extensive. The environment and its embedded technology support and provide the functionality to accomplish the learning objectives effectively.

The instructor and her instructional techniques are complemented by the technology in the environment. The technological capability of the PictureTel system allows the instructor to control and direct her remote class. The system allows VTC interaction that primes the students and initiates face-to-face interactions among them to start analysis and discussion of course material. After the discussion starts, the instructor still has the capability to direct the discussion and pace of the course through the audio and video channels. The technology allows the instructor to use the environment and her instructional techniques to conduct meaningful discussions and analysis that achieves the learning objectives of the course.

The instructor's teaching methods and course requirements encourage students to take charge of the class discussions and conduct inquiry in a cooperative manner. The small number of students in the course creates a more focused form of interaction between the students and between the students and instructors. Discussion among students and between the students and instructor is lively and carries strongly until the end of each class session and suggests that interaction functions well and involves all course participants. The students possess a genuine interest and enthusiasm while participating in the course sessions and seem satisfied with the progression and direction of the course.

VTC interaction between the instructor and students and face-to-face interaction between the students eventually develops as the instructor uses priming techniques to provoke thought and discussion. Most of the discussion occurs on the remote end of the communications channel among students. The instructor serves as a facilitator and director to guide and sustain the face-to-face interaction among students. The two-way audio and visual capabilities of the VTC system handle these requirements

very well allowing the instructor to provide enough input to control the remote class and students with her instructional techniques.

f. The Feedback Process

The feedback process exists on a real-time basis in the course. The course structure utilizing discussion and analysis provides an effective means of evaluation for the instructor. Feedback is received on a daily basis and is complete in the sense that all students provide input and thoughts on course subjects as the instructor uses cold call and initiates class discussions. The students conception and understanding of analysis can then be readily evaluated by the instructor and corrected as needed.

The relative lack of email capability at the remote site does not appear to impact the feedback process. This is probably due to the existence and strength of the other methods used in the course.

The instructor also uses visual cues to some degree to collect and evaluate feedback from the audience. A certain look on the face of a student could imply lack of understanding, boredom, or that the student would like to ask a question. The posture of the students while seated during a class session also provide visual cues to the instructor about the students interest in and understanding of the subject matter. The instructor relies upon these visual cues to adjust their instructional technique, change the pace or direction of the course, and clarify points. The traditional instructor in a face-to-face situation has no trouble seeing the students and interpreting the cues to adjust their course technique. The VTC instructor has become less dependent on this method due to the visual resolution of the PictureTel system. Professor Crawford modified her instructional techniques to deal with the system video resolution. She addresses direct questions to each student, listens to discussions, and asks for case synopsis instead of looking at the camera picture to discern student's facial mannerisms, questioning looks, or body language that suggests uninterest or lack of understanding. Professor Crawford can structure the techniques to address each student because of her small class size.

The instructors have also implemented written feedback in the form of case analysis reports presented by the students and SOFs completed at the mid-quarter and end-of-quarter points in the course. The preliminary results indicate a high level of student

satisfaction with the instructional technique, course material, and overall satisfaction for the course.

g. *Level of Interactivity*

The level of interactivity is strong and initiated early in the course. The technology and environment support the linking of the instructors and students in a manner that supports the instructors efforts to provoke discussion, question, and guide the students at the remote site. The instructor has no problem achieving the learning objectives for the course which utilize discussion and analysis to examine cases and experiences. The feedback mechanism that relies on real-time analysis of student constructs aids the instructors in frequent and complete validation of students' progression. Instruction methods help facilitate the guiding of class discussions and places educational responsibility with students in charge of active participation in the learning process.

D. COURSE COMPARISON

The three courses represent a broad range of learning outcomes that the model can be applied to. Each of the courses examined has different learning outcomes to demonstrate the flexibility and dynamic potential of the model. Every video teleducation course represents a unique mixture in terms of the technology and its role in the environment, the total learning environment, the effectiveness of the students and instructors, and the level of interactivity supported within the course. These elements combine to produce different effects and support for the learning outcomes of the course. The three NPS courses are compared using the elements of the model to demonstrate the importance, relationships, and inter-processes of the elements with respect to one another and to the overall learning effectiveness of the course.

1. Comparison of the Technology

The technology involved in the three courses taught at the NPS site is the same for all three courses. The technology at the remote sites is slightly different. The NRaD site has supplementary communications channels in the form of access to email and the Internet, while the other two sites, which were in the same facility at North Island, did not

have access. The availability of email and the Internet allowed Professor Bui to utilize a near real time system other than the main audio channel to conduct course business and provide a near real-time feedback channel between him and the students. Additionally, access to the Internet allowed Professor Bui to post the course material on a web page for easy access by the students. The other two courses relied upon the mail to deliver instructional materials and found inherent delays in using this delivery method.

The limitations of the technology, which were the audio clarity problem with the microphones and the visual resolution, only seriously affected Professor Doyle's course. His course was heavily dependent on graphics and charts as an instructional technique to accomplish course learning objectives. The video resolution impeded this instructional technique by limiting the clear display required by this type of media. Professor Bui's course was lecture and student presentation based with the students constructing and conducting presentations face-to-face at the remote site. Professor Crawford's instructional technique used the audio and video system to initiate discussion and analysis via VTC and then have the students interact face-to-face. Professor Doyle's instructional techniques were limited by the audio and video capability of the system. The audio clarity problem was enhanced by the fact that Professor Doyle had both local students at NPS and remote students at the same time, necessitating the need to turn the remote site microphones off and on to avoid the noise feedback. Professor Bui's and Crawford's courses only had students at the remote site.

The audio clarity also forced Professor Doyle to adjust his speech rate and take great pains to enunciate words clearly. Professor Bui, who has a heavy accent, avoided this problem by modifying his course structure and instructional technique to assign presentation responsibilities to the students, who could then interact face-to-face while Professor Bui monitored the course via VTC. Professor Crawford's instructional technique also limited the impact of the audio problem. Her technique supported face-to-face interaction among the students and only utilized the audio channel to initiate and guide the subject matter. The audio channel worked well with this instructional method.

Email also helped Professor Bui by providing an additional means of communication between the instructor and the students. The other two courses did not have email as an alternate means of supplementary communications.

2. Comparison of the Course Environments

The course environments differed in the respect that Professor Doyle's course had both local NPS and remote students. This is a problem in the environment as the instructor has to try to get the two groups to interact as if the two were in the same classroom. The technology discussed above indicates that the PictureTel system supports techniques that generate face-to-face interaction at the remote site while supporting a lesser amount of VTC interaction. In Professor Doyle's class, the audio and video limitations inhibited the environment to the extent that each group interacted within itself and with the instructor, but had very little interaction with each other. The effect was to generate two different classroom environments linked via VTC. The limitations of the technology combined in the environment compounded the problem of generating and sustaining interactivity. The courses taught by Professors Bui and Crawford only had student enrolled at a remote site, generating only one classroom environment for each instructor to contend with.

Another factor that affected the environment was the course scheduling. In Professor Doyle's course, the combination of NPS students and remote site students generated some dissatisfaction with both groups. The NPS students, being full-time, did not like the late hour of the course. The remote students, being part-time, appreciated the course timing that made it possible for them to keep their normal work schedule and attend class at the end of the work day.

The combination of the two student groups was further inhibited by the technological limitations and the heavy usage of visual media. These limitations fostered inconveniences on the part of both student groups with the remote class always seemingly behind the NPS class in obtaining a clear and timely view of the charts and graphs, and the NPS students waiting for the remote class to catch up. The result was the instructor had two separate class entities, instead of one interactive group. The technological problems and student differences led to the instructor using face-to-face interaction with the NPS

class and trying to use a large amount of VTC interaction with the remote class at the same time.

3. Comparison of the Instructor/Student Effectiveness Systems

As indicated earlier, instructional techniques differed within the three courses. The differences were due to the fact that the instructor used a particular technique in achieving a certain learning outcome or objective of his/her particular course. The courses were chosen due to their different learning objectives and it was expected to encounter different instructional methods used to achieve these objectives.

The course analysis and comparison indicates the different effects created by the interaction of the constructs within the learning effectiveness model. Instructor techniques that seemed to work well were ones that used the VTC component of interaction to place, initiate and sustain face-to-face interaction within the remote classroom. The instructor could then use the VTC interaction to guide, control the pace, and observe the remote classroom. Techniques that required heavy use of the VTC interaction, such as the media intensive course of Professor Doyle's, did not seem to work well because of the technological limitations.

Supplementary communications channels helped ease the demand upon the primary communications channel. The use of email provided an alternative and convenient method for Professor Bui to conduct business outside of class hours and the Internet provided an avenue for posting course materials and providing a research resource without relying on the slower system of mail delivery. The availability of these supplementary channels provided extra tools for the instructor and students to utilize.

Familiarity with the technology seemed to affect the effectiveness of the instructor. Professor Bui was at ease with the controls and layout of the NPS classroom and did not experience any trouble with combining the manipulation of media and controls with his course instruction. Professor Crawford found the layout to be comfortable but found the assistance of a technician to be helpful. Professor Doyle who was used to moving about the classroom as he instructs, found the layout to be confining and the extra tasks of manipulating the controls during course sessions to be difficult. It is notable that Professor

Doyle's course used a large number of slides, graphs, and visual media, while the other two courses did not. Professor Doyle changed the mechanics of his instructional approach by using a technician during every class session to manipulate the visual media, and cameras, while he lectured.

Student effectiveness was affected by student motivation. Part-time versus the full-time student provided different motivations for student effectiveness. The courses taught by Professor Bui and Professor Crawford had only part-time students, who attended class after their normal workday. Professor Crawford experienced student attrition as students had trouble balancing the course time requirements against family time, and job time. The students at NRaD also had to balance their time requirements; however, their primary motivation was that the course was perceived to be critical for career advancement. This requirement puts their motivation on a similar level as that of an NPS student who requires the course to complete the curriculum requirements and obtain a master's degree. Professor Crawford's and Professor Doyle's remote students do not have the attainment of a master's degree as a primary motivator. It is more important to fulfill their job at this point in their career.

4. Feedback Comparison

Feedback in the VTC environment allows the instructor to provide timely guidance to students and make adjustments in instructional techniques and course direction as necessary. This mechanism ideally should provide a near real-time exchange of information to allow timely adjustments and minimize differences in complex knowledge domains. The feedback mechanism provides knowledge and idea validation for the student.

All three courses had the same level of VTC feedback provided by visual and audio capabilities of the PictureTel system. This feedback was rather limited by the fact that the video resolution was less than ideal, so the instructors had less visual cues to utilize. Professor Crawford circumvented the resolution problem by adapting her instructional technique to use a seating chart to ask students direct questions and to analyze cases on a daily basis to validate their knowledge. The audio complication in Professor Doyle's

course limited his use of a similar technique to provide real-time feedback. Professor Bui's course had access to and utilized supplementary communications channels such as email and the Internet. These channels provided an alternative mechanism to support near real-time feedback and were used extensively by Professor Bui. Email and Internet access was not available for the other two courses.

All three courses utilized SOFs to obtain student feedback. SOF data is an indicator of overall student satisfaction with the course, but it is not real-time feedback that allows the instructor to adjust the course interaction as needed. The results can only be applied to future courses where the dynamics of the distance learning elements may be different rendering the SOF data obsolete.

5. Interactivity Comparison

The level of interactivity in the three courses differ. Professor Bui used instructional techniques that place the instructional responsibility upon the students and used supplementary communications channels to overcome the PictureTel system limitations and provide a near real-time feedback mechanism. This structure forced students to utilize the resources and conduct inquiry to construct and deliver their presentations. The instructional techniques used supported the achievement of the course objectives.

Professor Doyle used instructional techniques geared to presentation of visual media that demanded high resolution and audio clarity that could not be provided by the PictureTel system. His instructional technique was further impaired by having to devote his time to two distinct groups of students using face-to-face and VTC interaction at the same time. The manipulation of the visual media to present to the remote class also increased his tasking to the point that he required an assistant to manipulate the camera and video media while he lectured. The technology limitations and lack of supplementary communications channels limited the feedback mechanism in the course to mainly include SOFs and written exams. These methods while validating the material and indicating student satisfaction do not occur in real or near real-time that is required to adjust the course as it progresses.

Interactivity in Professor Crawford's class was sustained by her use of instructional techniques that used the VTC interaction to initiate face-to-face interaction in the remote classroom. Despite the lack of supplementary communications channels the two-way audio capability of the PictureTel system allowed her to guide discussion and control the course direction from the site at NPS.

V. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

A. RESEARCH QUESTIONS

The rapid advancement of communications technology is making possible a shift in educational strategy from traditional face-to-face instruction to distance learning. The Department of Defense (DOD) and Department of the Navy (DON) can benefit from the application of distance learning, specifically video teleducation (VTE) and video teleconferencing (VTC), to achieve savings in the areas of indirect and direct education and training costs. The DOD and DON are implementing VTC within their educational systems and training pipelines to achieve the benefits of cost/time savings as budgets are reduced. As VTC programs are implemented throughout the educational system, educators are discovering that the traditional educational models and methodology is inadequate when applied in a distance learning environment.

The objective of this research was to examine relevant distance learning literature for recurring elements that lend themselves as components of a dynamic educational model to apply to distance learning programs. The elements and their interaction in the model would let instructors and organizations examine individual VTC courses and gain an understanding of their effectiveness. The research questions were:

- *Do relevant criteria exist for the estimate and evaluation of a distance learning program?*
- *How do humans learn and what are the prevalent learning styles?*
- *How does videoteletraining change these styles?*
- *How does the role of the instructor and student change with the use of a videoteletraining program?*
- *If relevant criteria exist for distance learning, can these criteria provide a research design for measuring the effectiveness of a distance learning program?*

The scope of the research was limited to examination of current distance learning research for development of a distance learning model. This model was demonstrated by applying it to three Systems Management Curriculum courses taught via VTC at the Naval

Postgraduate School. The three courses were chosen to demonstrate the flexibility of the model in dealing with and evaluating courses with different learning objectives and outcomes.

The review of relevant literature in the field of distance learning indicates widespread interest in the application of VTC courses to education. The literature and research recognizes problems with applying traditional educational methodology and models to the VTC environment. Problems with distance learning courses include the evolution of the role of the instructor and the student, the technological limitations that affect the learning environment and its usefulness, and the evaluation of constructs that give insight into the effectiveness of a distance learning course. A research model is needed in order to evaluate the effectiveness of distance learning programs that are replacing other forms of training and education. The model would provide justification for training and ensure that the course goals and objectives are met. The research supports the existence of several elements that impact and influence the effectiveness of a distance learning course. While studies of different distance learning courses have been done, none have assembled crucial elements into an educational model to evaluate the effectiveness of a VTC course. The criteria identified in this model are:

- The technology in the environment
- The overall course environment
- The effectiveness of the instructor
- The effectiveness of the student
- The level of interactivity in the course.

These criteria and their inter-processes were examined and formulated into a dynamic model for application to three example VTC courses. The three courses were examined using the model and their outcomes compared to the learning objectives.

B. CONCLUSIONS

The conclusions reached in this paper are constrained by the fact that the findings are based on the model's application to and the results of only three NPS VTC courses.

Therefore, the sample size used was relatively small, which places qualifications on the validity of any conclusions made.

The first research question identified criteria that seemed to be relevant to a wide variety of distance learning programs. These criteria were the technology embedded in the environment, the classroom environment, the effectiveness of the instructors and students, the level of interactivity among these criteria, and feedback mechanisms. These components were used as the constructs of the distance learning model.

The second research question addressed the need for a suitable learning style supported in the distance learning environment. The roles of the students and instructors are different in the VTC environment. The student must be an active participant in the educational process and not just a passive recipient of knowledge. The student has greater responsibility for guiding their educational and knowledge development. The instructor provides resource access, guidance, and teaching methodology necessary to support the student's educational efforts in the course. These revised and newly identified roles suggest the use of constructivism as a proper methodology to foster knowledge development and place learning responsibility with the student in the distance learning environment.

Video teletraining involves complex interactions between the model criteria identified in the literature review. These elements build the foundation and support for interactivity in the course which sustains the flow of information and knowledge development in the program. The dynamics of the model emphasized the crucial role that feedback serves in the course and its enabling of the instructor to identify student achievement of the course objectives. This ability to gauge the student's understanding and completion of the course objectives seems to indicate the relative level of success of the course and its effectiveness in using the VTC environment to achieve the designated learning outcomes.

C. COURSE APPLICATION RESULTS AND THEIR SIGNIFICANCE

The three courses that were examined yielded somewhat different learning outcomes to provide evidence of the model's flexibility and demonstrate the interactions of

the model's elements and their complex relationships. Findings of interest were:

- The comparison of the results of the three courses indicate that different combinations and strengths of the elements produce different outcomes for the courses. For example, the technology and its limitations played a significant role in limiting the instructional techniques of Professor Doyle's course. The other two courses had their instructional techniques modified to shift the interaction to the remote site which compensated for the audio and video limitations of the PictureTel system.
- The technological limitations in the environment support teaching methods that place most of the interaction at the remote site. Those methods that require heavy media and graphics usage are handicapped by the available bandwidth.
- Factors that make the VTC course convenient as compared to the alternative provide motivation for the students. These factors include course scheduling, remote site location, the availability of tools that permit greater access to resources such as email and the Internet and increase access to the instructor.
- Combined audiences consisting of students at a remote site and students at the local site tend to interact as two separate bodies and not as one integrated group. Also, the factors of convenience may differ for these two groups.
- Instructor adaptation to the use of the technology varies and sometimes requires the aid of a technician to help 'produce' course sessions.
- Supplementary communications channels, such to include email, FTP, and the Internet, provide an indispensable means to communicate outside of normal class hours, provide course material, and reinforce the real time feedback mechanisms in the course.
- Interactivity in the course that brought about student discussion, inquiry, and placed the students in charge of their knowledge construction seemed to affect positively overall student satisfaction with the course.

D. RECOMMENDATIONS

The following recommendations are made to heighten awareness of DOD and DON planners as the military transitions its education and training programs to the distance learning environment. These recommendations are made with the point that an educational program's effectiveness is based on qualitative measures in addition to quantitative ones such as dollar savings. These recommendations should be applicable to various distance learning courses and provide the organization with an indicator of how well the students are achieving the objectives and goals set for the course. The model based on these measures should employ a mechanism to provide real or near real time information about student satisfaction with the course and understanding of the concepts/subject matter being taught. Specific recommendations are:

- Continue the validation of the proposed model by applying it to other distance learning VTC courses.
- Construct more rigorous, controlled conditions for VTC courses to apply the model to isolate different combinations of the variables to more clearly determine their effect upon the effectiveness of the course.
- Use these results to determine if an optimum combination of these elements exist that maximizes the learning effectiveness of a VTC course.
- Determine the technological needs for the instructor and student in the VTC environment to plan for the infrastructure required to support an effective distance learning program.
- Provide a means to tailor instructional techniques to aid achievement of learning outcomes for the course and support interactivity.

As the DON shifts educational strategies to implement distance learning, planners and educators must be able to assess effectiveness and justify budgetary expenditures for its training and educational programs. While distance learning and VTC hold promise for time and cost savings, they also generate different requirements for ensuring that the learning objectives are accomplished successfully.

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